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(54) **SYSTEM AND METHOD USING IMPULSE RADIO TECHNOLOGY TO TRACK AND MONITOR PEOPLE NEEDING HEALTH CARE**

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(56) **References Cited**

U.S. PATENT DOCUMENTS

4,641,317 A * 2/1987 Fullerton 375/130
4,675,656 A * 6/1987 Narcisse 340/539
4,743,906 A * 5/1988 Fullerton 342/27
4,813,057 A * 3/1989 Fullerton 375/259
4,979,186 A * 12/1990 Fullerton 375/239

5,363,108 A * 11/1994 Fullerton 342/27
5,519,400 A * 5/1996 McEwan 342/28
5,526,357 A * 6/1996 Jandrell 340/991
5,590,648 A 1/1997 Mitchell et al. 600/301
5,677,927 A * 10/1997 Fullerton et al. 375/200
5,687,169 A * 11/1997 Fullerton 370/324
5,832,035 A * 11/1998 Fullerton 375/149
5,963,130 A * 10/1999 Schlager et al. 340/539
6,026,125 A * 2/2000 Lerrick, Jr. et al. 375/295
6,111,536 A * 8/2000 Richards et al. 342/125
6,133,876 A * 10/2000 Fullerton et al. 342/375
6,177,903 B1 * 1/2001 Fullerton et al. 342/28
6,208,248 B1 * 3/2001 Ross 340/552
6,218,979 B1 * 4/2001 Barnes et al. 342/28
6,304,623 B1 * 10/2001 Richards et al. 375/355

OTHER PUBLICATIONS

U.S. patent application Ser. No. 08/761,602, Fullerton, filed Dec. 6, 1996.*

U.S. patent application Ser. No. 09/332,502, Fullerton et al., filed Jun. 14, 1999.*

U.S. patent application Ser. No. 09/146,524, Richards et al., filed Sep. 3, 1998.*

U.S. patent application Ser. No. 09/045,929, Fullerton et al., filed Mar. 23, 1998.*

U.S. patent application Ser. No. 09/083,993, Richards et al., filed May 26, 1998.*

U.S. patent application Ser. No. 09/332,503, Barnes et al., filed Jun. 14, 2000.

* cited by examiner

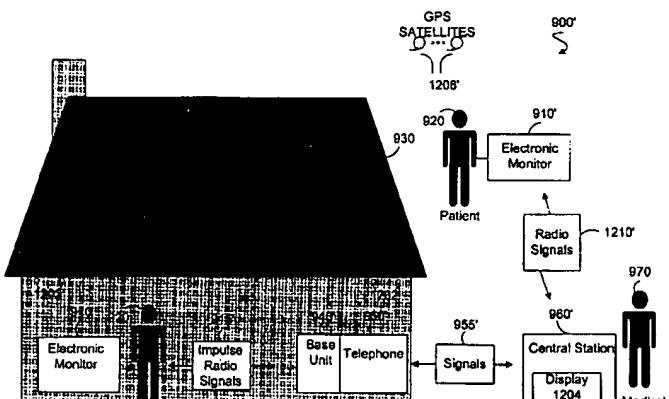
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(57) **ABSTRACT**

A system, electronic monitor and method are provided that utilize impulse radio technology to alert medical personnel when a patient needs medical assistance. In addition, the present invention includes a system, electronic monitor and method that utilize the communication capabilities and positioning capabilities of impulse radio technology to enable medical personnel to monitor one or more vital signs of a patient and/or to enable medical personnel to determine a current position of a patient in a building such as a hospital, nursing home or their home.

28 Claims, 24 Drawing Sheets



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Referring to FIG. 29, there is illustrated a diagram of an amplitude sensing architecture capable of being used in an impulse radio positioning network. Herein, the reference impulse radio units R1-R4 are likely time-synched. Instead of the electronic monitor M1 and reference impulse radio units R1-R2 measuring range using TOA methods (round-trip pulse intervals), signal amplitude is used to determine range. Several implementations can be used such as measuring the "absolute" amplitude and using a pre-defined look up table that relates range to "amplitude" amplitude, or "relative" amplitude where pulse amplitudes from separate radios are differenced. Again, it should be noted that in this, as all architectures, the number of radios is for illustrative purposes only and more than one mobile impulse radio can be implemented in the present architecture.

From the foregoing, it can be readily appreciated by those skilled in the art that the present invention provides a system, electronic monitor and method for alerting medical personnel when a patient needs medical assistance. In addition, the present invention provides a system, electronic monitor and method that utilize the communication capabilities and positioning capabilities of impulse radio technology to enable medical personnel to monitor one or more vitals signs of the patient and/or to enable medical personnel to determine a current position of a patient in a building such as a hospital, nursing home or their home.

Although various embodiments of the present invention have been illustrated in the accompanying Drawings and described in the foregoing Detailed Description, it should be understood that the invention is not limited to the embodiments disclosed, but is capable of numerous rearrangements, modifications and substitutions without departing from the spirit of the invention as set forth and defined by the following claims.

What is claimed is:

1. A system comprising:
 - an electronic monitor capable of being attached to a person located within a building, said electronic monitor includes:
 - an ultra wideband impulse radio transmitter capable of transmitting an impulse radio signal;
 - an ultra wideband impulse radio receiver capable of initiating an alarm for medical personnel located near a central station indicating that the person may need medical assistance whenever the ultra wideband impulse radio receiver fails to receive the transmitted impulse radio signal; and
 - a plurality of reference ultra wideband impulse radio units distributed at known locations throughout the building, wherein said central station is further capable of displaying a current position of the person within the building that was determined from the interaction between the ultra wideband impulse radio unit and at least two of the reference ultra wideband impulse radio units.
 2. The system of claim 1, further comprising a central station capable of sounding the alarm for the medical personnel.
 3. The system of claim 1, wherein said electronic monitor further includes a button used by the person to disable the ultra wideband impulse radio transmitter.
 4. A method for monitoring a person located within a building that may need medical assistance, said method comprising the steps of:
 - attaching, to the person, an ultra wideband impulse radio transmitter capable of transmitting an impulse radio signal;

alerting medical personnel located near a central station that the person may need medical assistance whenever an ultra wideband impulse radio receiver fails to receive the transmitted impulse radio signal;

determining a current position of the person within the building by enabling the ultra wideband impulse radio unit to interact with a plurality of reference ultra wideband impulse radio units that are distributed at known locations within the building; and

displaying, at the central station, the current position of the person within the building.

5. The method of claim 4, further comprising the step of utilizing a button controlled by the person to disable the ultra wideband impulse radio transmitter.

6. An electronic monitor comprising:

- a fastening mechanism capable of attaching said electronic monitor to a person located within a building;
- an ultra wideband impulse radio transmitter, coupled to the fastening mechanism, capable of transmitting an impulse radio signal to an ultra wideband impulse radio receiver capable of alerting medical personnel that the person may need medical assistance whenever the ultra wideband impulse radio receiver fails to receive the transmitted impulse radio signal; and
- said ultra wideband impulse radio unit is operable to interact with a plurality of reference ultra wideband impulse radio units such that medical personnel can track the position of the person within a building.

7. The electronic monitor of claim 6, wherein said person is a patient receiving health care in a hospital, a nursing home or a home.

8. An electronic monitor comprising:

- a fastening mechanism capable of attaching said electronic monitor to a person located within a building;
- an ultra wideband impulse radio transmitter, coupled to the fastening mechanism, capable of transmitting an impulse radio signal to an ultra wideband impulse radio receiver capable of alerting medical personnel that the person may need medical assistance whenever the ultra wideband impulse radio receiver receives the transmitted impulse radio signal; and
- said ultra wideband impulse radio unit is operable to interact with a plurality of reference ultra wideband impulse radio units such that medical personnel can track the position of the person within a building.

9. The electronic monitor of claim 8, wherein said person is a patient receiving healthcare in a hospital, a nursing home or a home.

10. A method for tracking and monitoring a person, said method comprising the steps of:

- attaching, to the person, an ultra wideband impulse radio unit;
- receiving, at a central station, information from the ultra wideband impulse radio unit relating to the person;
- displaying, at the central station, at least a portion of the information relating to the person that may need medical assistance;

determining a current position of the person within a building by enabling the ultra wideband impulse radio unit to interact with a plurality of reference ultra wideband impulse radio units that are distributed at known locations within the building; and

displaying, at the central station, the current position of the person within the building.

11. The method of claim 10, wherein the information relating to the person includes a monitored vital sign of the person.

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12. The method of claim 10, further comprising the step of determining a current position of the person located outside the building by enabling the ultra wideband impulse radio unit which coexists with a Global Positioning System (GPS) receiver to interact with a plurality of GPS satellites. 5

13. The method of claim 10, further comprising the step of establishing communications between the person attached to the ultra wideband impulse radio unit and medical personnel using the central station.

14. The method of claim 13, wherein said step of establishing communications further includes enabling the medical personnel using the central station to notify the person that it is time to take medication. 10

15. The method of claim 10, further comprising the step of coupling a sensor to the ultra wideband impulse radio unit, wherein the sensor is capable of monitoring at least one vital sign of the person. 15

16. A system comprising:
an electronic monitor, attached to a person, including an ultra wideband impulse radio unit capable of transmitting an impulse radio signal containing information relating to the person; 20

a central station capable of obtaining the information and further capable of displaying at least a portion of the information relating to the person that may need medical assistance; and 25

a plurality of reference ultra wideband impulse radio units distributed at known locations throughout a building, wherein said central station is further capable of displaying a current position of the person within the building that was determined from the interaction between the ultra wideband impulse radio unit and at least two of the reference ultra wideband impulse radio units. 35

17. The system of claim 16, wherein said electronic monitor further includes a sensor capable of monitoring at least one vital sign of the person.

18. The system of claim 16, wherein at least one of said reference ultra wideband impulse radio units further supports an ultra wideband impulse radar operation which enables the at least one reference ultra wideband impulse radio unit to sense the movement of another person not carrying the electronic monitor within the building. 40

19. The system of claim 16, wherein said central station is further capable of displaying a current position of the person located outside the building by enabling the ultra wideband impulse radio unit which coexists with a Global Positioning System (GPS) receiver to interact with a plurality of GPS satellites. 45

20. The system of claim 16, wherein said central station is further capable of alerting medical personnel whenever the person tampers with the electronic monitor. 50

21. The system of claim 16, wherein said medical personnel using the central station are capable of communicating with the person attached to the electronic monitor.

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22. The system of claim 21, wherein said medical personnel using the central station are capable of notifying the person that it is time to take medication.

23. An electronic monitor comprising:
a fastening mechanism operable to attach said electronic monitor to a person;
a sensor operable to monitor at least one vital sign of the person;

an ultra wideband impulse radio unit operable to interact with said sensor such that medical personnel can monitor the at least one vital sign of the person; and
said ultra wideband impulse radio unit is operable to interact with a plurality of reference ultra wideband impulse radio units such that medical personnel can track the position of the person within a building.

24. The electronic monitor of claim 23, further comprising a Global Positioning System (GPS) receiver capable of interacting with a plurality of GPS satellites such that medical personnel can track a position of the person located outside a building.

25. The electronic monitor of claim 23, further comprising an interface unit operable to sound an alarm wherever the person tampers with the electronic monitor.

26. The electronic monitor of claim 23, further comprising an interface unit that enables medical personnel to communicate with the person.

27. An electronic monitor comprising:
a fastening mechanism operable to attach said electronic monitor to a person;

an ultra wideband impulse radio unit, coupled to said fastening mechanism, operable to interact with a plurality of reference ultra wideband impulse radio units such that medical personnel can monitor a position the person within a building, wherein the position of the person is determined by:

30 synchronizing the reference ultra wideband impulse radio units;

35 synchronizing the ultra wideband impulse radio unit to the synchronized reference ultra wideband impulse radio units;

40 collecting and time-tagging range measurements between the ultra wideband impulse radio unit and at least two of the reference ultra wideband impulse radio units; and
45 calculating the position of the person within the building carrying the electronic monitor containing the ultra wideband impulse radio unit using the collected and time-tagged range measurements.

50 28. The electronic monitor of claim 27, further comprising a sensor, coupled to said ultra wideband impulse radio unit, operable to monitor at least one vital sign of the person.

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